Coppei Creek Area 07 Conceptual Basis of Design Report

For Walla Walla County Conservation District
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2D – two dimensional

BBR – BPA Restoration Review Team

BPA – Bonneville Power Administration

CREP – Conservation Reserve Enhancement Program

CTUIR – Confederated Tribe of the Umatilla Indian Reservation

DW – diffusion wave

GPDSR – General Project and Data Summary Requirements

HEC-RAS – Hydraulic Engineering Center's River Analysis System

HEC-SSP – Hydrologic Engineering Center's Statistical Software Package

HIP – Habitat Improvement Program

NAD 83 – North American Datum of 1983

NAD 83 HARN -- North American Datum of 1983 HARN

NAIP – National Agriculture Imagery Program

NAVD 88 – North American Vertical Datum of 1988

Project – Project Area 07 on Coppei Creek

RCO – Washington State Recreation and Conservation Office

Report – 30 Percent Preliminary Basis of Design Report

Rio ASE – Rio Applied Science and Engineering

RM – river mile

sta. – station

Structures – instream habitat structures

SWE – shallow water equation

USACE – U.S. Army Corps of Engineers

USDA – U.S. Department of Agriculture

USGS – U.S. Geological Survey

WDFW – Washington Department of Fish and Wildlife

WSA – Water Surface Elevation

WWBWC – Walla Walla Basin Watershed Council

WWCCD – Walla Walla County Conservation District

1 INTRODUCTION, GOALS, AND OBJECTIVES

Rio Applied Science & Engineering (Rio ASE) has prepared this 30 Percent Preliminary Basis of Design report (report) for Walla Walla County Conservation District (WWCCD). This report provides a summary of our findings pertaining to the existing conditions of the Project Area 07 on Coppei Creek located between Dixie, Washington, and Waitsburg, Washington, and an explanation of the design process, analyses, and outcomes for the proposed enhancement design.

Rio ASE organized the following sections of this report to describe the General Project and Data Summary Requirements (GPDSR) required by the Bonneville Power Administration (BPA) for regulatory compliance coverage under the Habitat Improvement Program (HIP). This report is submitted to satisfy the 30 Percent Design review for technical comment as part of the Washington State Recreation and Conservation Office (RCO) review and will be used for the BPA Restoration Review Team (RRT) review process. BPA developed the requirements to effectively communicate that appropriate planning, analysis, design, and resulting construction documentation obligations are met. The conditions of the project reach are described in terms of processes that shaped the stream and associated ecosystem. This includes discussions on hydrology, hydraulics, habitat, and geomorphology. The evaluation and consideration of the site conditions provide the basis for the project design.

1.1 Project Responsible Parties

- The project sponsor is Walla Walla County Conservation District and the project manager is Grant Traynor, 509-956-3762.
- The design consultant is Rio ASE and the engineer of record is Jeff Fealko, 208-866-8753.

1.2 Site Location

The Project reach is on the mainstem of Coppei Creek, downstream from the confluence of the North and South Fork of Coppei Creek in Walla Walla County, Washington. The Project reach is located between river mile (RM) 6.5 and RM 8.11 upstream of Waitsburg, Washington. This project area is located in reach C-7 as identified in the Upper Touchet Basin Habitat Restoration Geomorphic Assessment and Restoration Prioritization report (Anchor QEA, 2020).

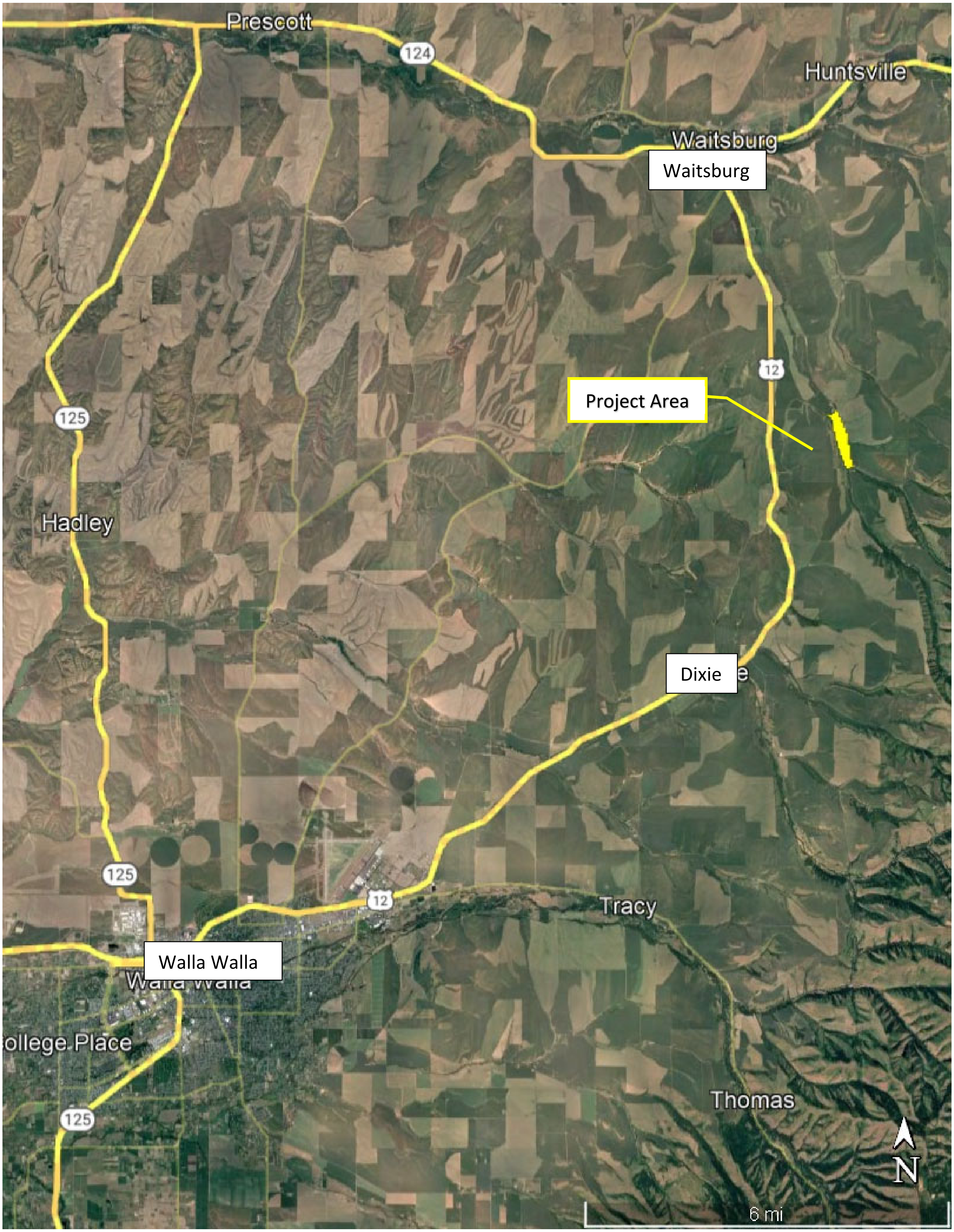

Figure 1-1. Map of project vicinity.

1.3 Project Background

Rio ASE is working with the WWCCD in the development of a conceptual and preliminary design for the Coppei Creek Project Area C-7 (Project). The project reach is located in a rural area with single family residential houses interspersed within agricultural fields. Agricultural use dominates the watershed upstream and downstream as well. Coppei Creek contains some of the most valuable habitat for adult and juvenile salmon and steelhead in Walla Walla County, primarily located upstream of the confluence of the North and South forks. This site and other high priority reaches were originally identified in the Upper Touchet Habitat Restoration Geomorphic Assessment and Restoration Prioritization (Anchor QEA, 2020).

1.4 Limiting Factors

It is suspected that prior to modification over the last ~200 years, Coppei Creek encompassed a pool-riffle main channel containing the majority of the flow, along with some side channels that were typically inactive at low flow. Beaver dams, probably built during low water, were not likely to last in the main channel due to stream power, but may have occupied side channels and relic main channels extensively. A common side channel morphology was likely a side channel disconnected at the upstream end at low flow, but with a perennial downstream connection. The main channel likely moved via avulsions, both small- and large-scale. When the main channel avulsed out from the riparian corridor into grassland, it likely formed a more meandering planform with the bends migrating downstream and/or laterally. Land-use practices and other anthropogenic effects have altered the characteristics of Coppei Creek, creating multiple areas of concern. Previously identified limiting factors in the Project reach include the following:

- High instream temperatures
- Excessive sediment load (fine grained)
- Channel stability
- Inadequate summer flow
- Lack of habitat biodiversity
- Lack of key habitat quantity (lack of pools)
- Lack of large woody material in the channel
- Channel confinement (restricted floodplain access)
- Poor riparian function

1.5 Project Goals and Objectives

To address the highest priority limiting factors in Coppei Creek, as summarized in the Touchet Geomorphic Assessment, target objectives include (Anchor QEA, 2020):

Table 1-1. Middle Touchet (Coppei to Patit Creeks) Habitat Objectives

Habitat Factor	Priority	Middle Touchet Objective
Embeddedness	I	Less than 10% embedded
Temperature	II	No more than 4 days above 72°F
Large Woody Debris	III	One or more pieces per channel width
Confinement	IV	Less than 15% to 40% of streambank length

The primary goal of this project is to develop more normative river and floodplain functions to enhance habitat diversity, increasing the capacity of the project reach to support juvenile life stages of Chinook salmon and steelhead. This goal will be met by targeting the following objectives to meet those objectives identified above:

- Increase the frequency of channel units (i.e., more pools) to 1 pool per 7 channel widths (large woody debris, temperature, embeddedness)
- Improve and increase baseflow fish cover quantity and quality including interstitial spaces of comparable size to juvenile salmonids for concealment cover (embeddedness, large woody debris)
- Increase availability of reduced water velocity (and increase diversity of available velocities) across a broad range of flows to decrease fish bioenergetic demands (embeddedness, confinement)
- Distribute stream flow and energy onto the floodplain, thereby reducing the available stream power concentrated into one primary channel (make the existing 5-year inundation extents equal to the those of the 2-year at proposed conditions) (temperature, confinement)
- Increase density of native riparian plant communities for long-term shade and bank stability (the existing 5-year floodplain is vegetated with maturing riparian trees) (temperature)
- Increase large woody debris to aid in hydraulic diversity and meet habitat objectives of one or more pieces per channel width (large woody debris)
- Do not increase flood hazard risk to any landowner’s structures (e.g., houses, barns, etc.)

2 SITE CHARACTERIZATION

2.1 Hydrology

Coppei Creek watershed at the project site has a contributing basin area of 24.14 square miles and contains over 2,600 feet of elevation change from 1,600 feet up to 4,200 feet. The basin receives on average 37.6 inches of precipitation per year (U.S. Geological Survey [USGS], 2022). The overall climate is primarily continental and the basin receives the majority of its precipitation in the form of snow from late fall to early spring (Anchor QEA, 2020). The basin drains in a northwesterly direction and largely receives runoff from the western front of the Blue Mountains. Peak discharges can occur at two different time frames due to the elevation range of the basin. The first peak is typically a rain on snow event that occurs in early- to mid-winter (January); the second is based directly on snowmelt that occurs during late spring to early summer.

There are no gaging stations within Coppei Creek to develop critical peak and low flow discharge events for design purposes. From 2012 to late spring 2016, the Walla Walla Basin Watershed Council (WWBWC) managed a short-term gage on Coppei Creek near the mouth downstream. However, only the 2016 data is available on the WWBWC website; this gaging station was not utilized because of the limited data. To develop peak and other critical flows for Coppei Creek, we utilized three USGS gaging stations nearby and developed a basin area regression to estimate discharge values for the Coppei Creek at the project site. The three gaging stations were identified based on location, watershed aspect, drainage basin size, and period of record. The three gages used in this analysis are summarized in Table 2-1.

Table 2-1. USGS Gaging Stations Utilized in Hydrologic Analysis for Coppei Creek

Creek	Gage No.	Drainage Area (mi^2)	Period of Record	Longitude	Latitude
Blue Creek	14013500	17.0	1940-1971	118°08'21"	46°03'28"
Dry Creek	14016000	48.4	1949-1967	118°14'10"	46°07'20"
Mill Creek	14013000	59.6	1940-2021	118°07'03"	46°00'29"

The historic gage data available from these three gages were utilized in the Hydrologic Engineering Center's Statistical Software Package (HEC-SSP) program and were evaluated to estimate both annual peak flood flows as well as annual daily exceedance values (HEC, 2022). To evaluate the peak flow data and compare them to each other, a MOVE.3 statistical extension was performed to create synthetic peak discharges for all gages from 1940-2021. This methodology is the recommended method for record extension based on USGS Bulletin 17C (USGS, 2021). The peak flow records were then analyzed using the EMA Log Pearson Type III analysis, as discussed in USGS Bulletin 17C, to estimate discharges associated with select flood frequency recurrence intervals (USGS, 2021). To estimate the peak flood frequency discharges at the project site, a log regression and a linear regression were fit to the data for basin area and discharge for each selected flood interval. The average of these two regressions were used as the estimated discharge at the project site. The peak flood discharges for the project site are summarized below in Table 2-2. These estimated values were compared to previous methods and were determined to be valid.

Table 2-2. Select Peak Discharges (cfs) for the USGS Gage Locations and Coppei Creek Area 7 Project Reach Based on Average of a Logarithmic and Linear Regression Between Discharge and Basin Area

Exceedance Probability	Blue Creek 17.0 mi^2	Dry Creek 48.4 mi^2	Mill Creek 59.6 mi^2	Coppei Creek Project Site 21.1 mi^2 Ave. (Linear Reg. – Log Reg.)
0.667	177	411	725	259 (233 - 285)
0.5	247	591	947	361 (328 - 394)
0.2	484	1,183	1,678	701 (646 - 757)
0.1	698	1,690	2,326	1,002 (927 - 1,078)
0.05	952	2,262	3,090	1,353 (1,254 - 1,453)
0.02	1,360	3,127	4,323	1,906 (1,768 - 2,044)
0.01	1,733	3,873	5,460	2,403 (2,229 - 2,577)

In addition to peak recurrence discharges, annual daily exceedance values were estimated for the 95%, 50%, and 5% exceedance values. The 95% annual daily exceedance flow is the average daily discharge that is equal to or exceeded 95% of the year, which is typically utilized to evaluate fish passage at low flows and tends to represent low summer flow conditions. The 50% exceedance is equal to or exceeded 50% of the year and represents a mid-range flow often typical of later winter or early spring conditions. The 5% exceedance flow is a higher flow exceeded only 5% of the year and is typically utilized to evaluate fish passage at high flow conditions. To evaluate exceedance flows, the three USGS gages were evaluated for their respective periods of record. To estimate the exceedance discharges at the project area, a logarithmic and linear regression were fit between the discharge and drainage basin area in the same manner as the peak discharges. The average of those two regressions was used as the estimated value. The annual daily average discharge exceedances are displayed in Table 2-3 below.

Table 2-3. Annual Daily Exceedance Discharges (cfs) for the USGS Gage Locations and Coppei Creek Area 7 Project Reach Based on Average of a Logarithmic and Linear Regression Between Discharge and Basin Area

Annual Daily Exceedance	Blue Creek 17.0 mi^2	Dry Creek 48.4 mi^2	Mill Creek 59.6 mi^2	Coppei Creek Project Site 21.1 mi^2 Ave. (Linear Reg. – Log Reg.)
95%	1	1	25	2.1 (0.9 – 3.3)
50%	5	8	58	8.7 (6.1 – 11.3)
5%	61	81	281	79 (68 - 89)

These exceedance values were compared to observed flows at the project site during both our spring and our late summer site visits and appeared to be representative of conditions. Discharge measurements were taken during the site visit in spring of 2022; these flows were used for hydraulic model calibration purposes. Measurements were taken on the South Fork Coppei Creek, North Fork Coppei Creek, and at the downstream end of the project area on Coppei Creek. Table 2-4 summarizes the flows measured on April 5, 2022.

Table 2-4. Measured Discharges on Coppei Creek Through the Project Area on 4/5/2022

Location	Discharge (cfs)
North Fork Coppei Creek	5
South Fork Coppei Creek	8
Downstream Project Limits Coppei Creek	13

2.2 Geomorphology

This section provides conclusions regarding the fundamental physical characteristics of Coppei Creek and the surrounding valley, and the fundamental processes controlling the form and function of the river. The analysis synthesizes qualitative field observations and quantitative survey data to provide an assessment of the dominant underlying processes in Coppei Creek and how they differ from expected conditions and processes for this reach. Based on existing conditions and processes, potential restoration opportunities to improve function in a feasible manner for this reach can be identified.

2.2.1 Geomorphic Observations

Horizontal and vertical constraints on Coppei Creek influence and determine channel morphology. At the project site, the South Fork and North Fork Coppei Creek come together in an unconfined valley setting. Near the confluence, the South Fork and North Fork are constrained by bridges on both tributaries, levees, rock crib walls, and bedrock near the valley-left hillslope. Downstream until roughly station (sta.) 22+00 (See Appendix B Sheet 3 for stationing reference), Coppei Creek is horizontally confined by the hillslope on the left and a high floodplain on river right, producing a single-thread, pool-riffle morphology with alternating bars. From sta. 36+00 to 57+00, Coppei Creek has avulsed from the former main channel location and has formed a meandering, pool-riffle morphology. At the downstream end of the project reach, Coppei Creek is horizontally constrained by steep hillslopes on the left and the bridge grade for a defunct railroad line. Coppei Creek is vertically constrained at the upstream and downstream end of the project by shallow basalt bedrock that is present at surface within the stream channel and banks. Within the project area, levees on the upstream end of the project and vertical floodplain disconnection reduce the connectivity between floodplain and channel.

The riparian plant community throughout the project reach is spatially variable in age class and species composition. Vegetation in a portion of the project reach riparian area has been a part of the Conservation Reserve Enhancement Program (CREP) for approximately twenty years, with some riparian planting also done by landowners. In most areas, there is an intact riparian corridor of vegetation, with mature trees and extensive overhanging canopy cover. Where Coppei Creek avulsed from the location of the CREP planting (sta. 36+00 to 57+00), the channel cuts through a canary reed grass and Himalayan blackberry-dominated meadow.

Sediment transport dynamics in Coppei Creek play a major role in the channel morphology. Coppei Creek appears to be sediment transport limited where not horizontally constrained, with substantial amounts of coarse bedload transport and deposition occurring within the system. Where locally constrained, the channel functions as a sediment transport reach, with subsequent downstream deposition where the channel widens and stream flood depth decreases. Along with upstream contributions, cut banks into the geological Touchet formation and loess cliffs supply coarse and fine sediment, respectively, to the stream. The meandering channel in the open meadow (sta. 36+00 to 57+00) also provides a local source of predominantly fine sediment to the stream channel.

Avulsions appear to be the main cause of changes in channel location throughout the project reach. The avulsion potential increases where Coppei Creek is less laterally constrained, which coincides with sufficient accessible floodplain area to form side channels. In the inlets of side channels, there is often a packet of coarse sediment deposition that appears to have been associated with directing flow away from the current side channel (former main channel) into the current main channel (former side channel), either causing or hastening the avulsion. Where there is a substantial flow split, the ability of either channel to convey bedload is reduced, resulting in deposition at the flow split, concentrating flow into one of the channels. If the channel that has the majority of flow was not initially the main channel, that channel will likely locally expand until the channel geometry can convey the floodwater and bedload. This erosion will locally increase bedload transport and can result in downstream deposition. When coupled with the observed channel confinement, this pathway is suspected to be a reason that there are few side channels active at low flows (i.e., side channels that are active at low flow likely convey enough water at peak floods for coarse bedload conveyance and deposition).

Channel obstructions tend to cause substantial local geomorphic responses where bank stability is not high. Where channel obstructions such as large woody debris occur, the channel typically responds with scour pools and localized deposition. Where large wood is in the channel, small wood also tends to rack onto the jam, increasing geomorphic response. Near sta. 34+00, bank protection and rootwads have been placed to protect local infrastructure. Many of these structures have produced local scour. While beaver impacts were seen within the project bounds, no beaver dams obstructing flow were observed.

Another influence on local geomorphic response is the spatially variable bank erosion resistance. In some locations, the Touchet formation provides sufficiently high bank stability to allow for extensive creation of undercuts. Bank stability is also provided in many locations by tree roots with high root density and deep rooting depths, which facilitates the formation of pools and undercuts. Where flow has been forced into the hillslope, several vertical loess cliffs have been formed and likely provide substantial fine sediment to the stream channel when hillslope failure occurs. Where bank stability is low, bank erosion is more substantial, creating a higher width-to-depth ratio channel exhibiting higher rates of channel migration.

2.2.2 Existing Geomorphic Conditions

Field observations were synthesized to identify the key geomorphic processes within the project site that will inform potential restoration efforts. Restoration designs should focus on these processes to maximize the effectiveness and sustainability of restoration efforts.

- Lateral constraints: Lateral constraints on channel movement and accessible floodplain drive the differences in morphology within the project reach. Levees and a lack of accessible floodplain constrain the channel in the upstream portion of the project reach, producing the alternating bar morphology. In the downstream portion of the project reach, the channel is sufficiently unconstrained to create a wide-spread avulsion into an area with lower bank stability, creating a more meandering planform.
- Coarse bedload: The coarse bedload that deposits in areas where conveyance is reduced drives avulsions and abandonment of side channels.
- Shallow bedrock: Where bedrock is present, the channel is vertically constrained. Bedrock tends to appear in areas where the channel is pushing up against the left hillslope.
- Large woody debris presence: Where large woody debris is interacting with the stream, local scour and deposition produce channel and hydraulic complexity.
- High bank cohesion: Where high bank cohesion is present, vertical banks, undercuts, and a low width-to-depth ratio are much more common. Bank cohesion, which can be due to either roots or the Touchet formation, is patchy and not continuous throughout the site.

2.3 Fish Use and Habitat Availability

Coppei Creek supports two ESA-listed Mid-Columbia River salmonid populations throughout or a portion of their life history stages. Summer steelhead (*Oncorhynchus mykiss*) and bull trout (*Salvelinus confluentus*) were identified in the Walla Walla Subbasin Plan as aquatic focal species (WWWPU and WWBWC 2004). In addition, while not ESA-listed, both the Confederated Tribes of the Umatilla Indian Reservation (CTUIR) and Washington Department of Fish and Wildlife (WDFW) have released spring Chinook salmon into the Touchet River and Walla Walla River for reintroduction (Anchor QEA, 2020).

Summer steelhead enter the Touchet River system as early as October and typically spawn from late February to late May, including in Coppei Creek. Once emerged from the gravels, juveniles rear in Coppei Creek throughout the year and then migrate from mid-October through June (Anchor QEA, 2020).

Reintroduced adult spring Chinook salmon enter the system in late April through June, will hold over the summer and then spawn in late August to the end of September. Juveniles will rear year-round. It is believed that mainstem summer temperatures in the Touchet River downstream of Dayton are marginal or lethal for spring Chinook juveniles, and tributaries in this area could be an important refuge zone if temperatures are acceptable for those juveniles to seek out and hold over.

Documentation on bull trout in Coppei Creek is not great, and the geomorphic assessment states that there is no spawning or juvenile rearing in Coppei Creek (Anchor QEA, 2020). If present they would likely be in a migratory state either up or down river associated with spawning activity occurring in late August through October.

2.4 Riparian Conditions and Wetlands

The project site is located within a narrow riparian corridor that transitions to agricultural ground directly adjacent. The riparian corridor contains a mix of age classes of riparian tree overstory and other small woody bushes. Portions of the project have been historically enrolled in the CREP, which has included tree planting efforts and native riparian recovery. Coppei Creek has avulsed from a segment of this CREP area and now flows through a more open meadow consisting of reed canary grass, Himalayan blackberry, and wild rose bushes.

The wetlands of the project site have yet to be assessed. The preliminary designs will be used to determine an appropriate study area and evaluate wetlands during the next design iteration.

2.5 Other Relevant Conditions

There are water rights being diverted out of Coppei Creek through surface water extraction with a screened pump. These water rights will have to be maintained. Current pump intakes are located in small pools; they appear to be removed each fall and placed back in the spring.

3 ALTERNATIVES ASSESSMENT AND SELECTION

Two alternative designs were developed for the project area based on historic and existing geomorphic conditions, project constraints, and overall goal and objectives to address limiting factors for salmonids within the reach. Alternatives were initially developed utilizing conclusions from the previous work done for the Touchet Geomorphic Assessment and Restoration Prioritization (Anchor QEA, 2020). Alternatives can be viewed in Appendix A. Alternative 1 consists of large wood additions, grade controls/channel-spanning jams at select locations, and riparian plantings. Alternative 2 builds on Alternative 1 with the removal of a select portion of a levee as well as a development of a protection levee around existing infrastructure. The most significant addition within this alternative is the protection levee that relocates a stream expansion zone from adjacent infrastructure to downstream where there is more flexibility in allowing natural channel processes to occur. The following items were considered when developing both alternatives.

- **Connection to Project Goals and Objectives**: Both alternatives satisfy the goals and objectives of this project.
- **Tangible Benefit to All Targeted Species and Life Stages:** Both alternatives will produce a tangible benefit to all targeted species through gravel sorting, pool development, floodplain activation, large wood additions, shade through riparian revegetation, etc.
- **Stakeholder Comments and Community Support:** Both alternatives were developed with support from stakeholders and vetted through landowner concerns and constraints.
- **Economic Feasibility (appropriate cost-to-benefit ratio)**: Alternative 2 is more expensive due to increased earthwork activities associated with levee removal and levee construction. Alternative 2 may impact natural process more due to the levee additions, but both alternatives are economically feasible.
- **Likelihood of Success:** Both alternatives have a high likely hood of success; however, Alternative 2 may be slightly riskier given the reliance on a new levee structure to reduce flooding in critical infrastructure areas.
- **Ongoing Maintenance Requirements:** Both alternatives will likely require a low amount of maintenance since both alternatives target a geomorphically appropriate and stable system. Alternative 2 may require more maintenance given the construction of a new levee segment which may require adjustments after high flow events.
- **Project Sustainability and Resilience:** Both alternatives are sustainable long term and show resilience through utilizing natural restoration methods. Large wood, boulders, and bedrock are all naturally present in the channel and its location nestled along the left valley wall provides future access to these items as well.

Alternative 1 with some modifications is the preferred alternative after receiving feedback from stakeholders and landowners. Modifications to Alternative 1 include the removal of the portions of levees identified for removal near the upstream end in Alternative 2. These removals increase floodplain connectivity within the upper reach. Additional modifications include the development of multiple connections to the relic channel in the lower half of the project area. These connections are more natural solutions to reconnecting historic channels at more frequent flows. The preferred alternative does not include the levee reconfiguration as proposed in Alternative 2, which should allow the system to function more naturally without additional confinement. The preferred alternative has been developed into the conceptual (30%) design package presented in Appendix B.

4 DESIGN CONSIDERATIONS, EVALUATIONS, AND ANALYSES

4.1 Restoration Opportunities

Restoration treatments in Coppei Creek can help improve stream-floodplain processes and enhance the habitat limiting factors for salmonids. By making use of currently functioning processes, it is possible to place the project reach processes on a trajectory to improve and sustain stream function to a more normative condition.

The restoration treatments proposed for the Project are intended to encourage natural channel and habitat-forming processes. While providing near-term functional and habitat benefits, the vision for the restoration treatments is an evolution of geomorphic and habitat characteristics over annual and decadal time scales that will improve the factors limiting salmon recovery in Coppei Creek. These restoration treatments are intended to provide the functional processes of:

- Increased floodplain connectivity and activation of secondary channels
- Increased riparian vegetation growth
- Increased in-stream habitat complexity

The proposed restoration opportunities were originally developed through the Upper Touchet Basin Habitat Restoration Geomorphic Assessment and Restoration Prioritization developed in 2020 (Anchor QEA, 2020). This document identified the following proposed treatments for the Project area:

- Levee Setback/Removal Areas (Floodplain Connectivity)
- Pilot Channel Excavation (Increased In-stream Habitat Complexity)
- Large Wood Addition (Increase In-stream Habitat Complexity)
- Riparian Revegetation (Increase Riparian Vegetation Growth

Using the geomorphic assessment as a starting point, two feasible alternatives were developed during the 15% design stage. These alternatives each included elements from the geomorphic assessment. One alternative had more levee creation and setback work than the other. These alternatives were discussed with the client and landowners through the project reach in September 2022. Discussion was had on landowner constraints, concerns, and fish needs. Ultimately, the proposed preliminary design plans prepared as Appendix B in this document are the result of the alternatives analysis and overall preferred concept. As with most alternatives evaluations, portions of each alternative were combined to create a project that provides the most natural restoration potential while still meeting landowner constraints. To maximize the three functional processes identified above, multiple design elements were incorporated and are described below.

4.2 Design Elements

Add instream structure (wood and/or boulders): Coppei Creek has shown a positive local response to instream structure; increased density of instream structure will produce greater amounts and diversity of habitat (e.g., channel unit frequency). The evidence of small wood racking onto existing large wood also indicates that instream structure will be able to change and grow over time. This treatment will promote:

- Increased channel unit frequency
- Localized deposition and scour (gravel sorting including spawning-sized gravels)
- Additional long-term wood recruitment
- Reactivation of historic side channels
- Increased hydraulic diversity
- Increased cover for juveniles

Add grade control structures (constructed riffle or channel-spanning large wood material jams) at select locations: Coppei Creek appears to respond to channel-spanning structures in a positive manner. There were multiple examples of historically placed rock weirs that were promoting localized aggradation and providing some stabilization to river location. While rock weirs are more of a historical treatment, riffles constructed of natural materials can act as a good alternative to increase channel bed elevation. There were also signs of a series of small channel-spanning woody material blockages that had built up and ultimately blown out, but resulted in side channel development and localized aggradation and scour. Both constructed riffles and channel spanning large wood jam treatments will promote:

- Floodplain activation
- Backwater bedrock pools for increased depth and sediment aggradation
- Gravel sorting
- Activation of secondary channels
- Increased cover for juvenile salmonids
- Increased hydraulic diversity

Levee removal or setback: Throughout the project reach Coppei Creek has been historically restricted by a series of "sugar" levees in attempts to limit floodplain utilization by the river. Removing some of these features at select locations will promote:

- Increased floodplain activation
- Reduced water velocities
- Increased hydraulic diversity
- Increased diversity of available habitats during high flows
- Reduced stream energy
- Increased riparian corridor vegetation and width

Add riparian plantings in avulsion channel segment: In sections of floodplain near the downstream portion of the reach there is a lack of mature vegetation that can provide sufficient rooting depth for long-term bank stability. This area is currently largely occupied by reed canary grass and Himalayan blackberry, two species that are not ideal for riparian recovery. The adjacent area that was enrolled in CREP (historic channel) previously saw great success in the establishment of a forested riparian corridor. The proposed planting would promote:

- Shade development for thermal buffering
- Increased bank stability
- Reduced fine sediment inputs from within the reach
- Future large wood recruitment

4.3 Hydraulic Modeling and Analysis

The purpose of the existing conditions hydraulic model is to determine the hydraulic conditions (depth, velocity, shear stress, and water surface elevation) to evaluate existing floodplain connectivity, evaluate in-channel and floodplain habitat conditions at high and low flows, and provide the basis for comparison with future proposed conditions hydraulic modeling to ensure project objectives are being met. The existing conditions 2D hydraulic model was developed using the U.S. Army Corps of Engineers (USACE) Hydraulic Engineering Center's River Analysis System (HEC-RAS), version 6.3.1.

4.4 Data Used

Data used to develop the two-dimensional (2D) hydraulic model includes topography and bathymetry, aerial imagery, and hydrology, which is discussed in a previous section.

4.4.1 Topography and Bathymetry

Topographic and bathymetric information used to create existing and proposed ground surfaces (terrains) for use in the hydraulic model and for design includes the following data sources:

- 2022 bathymetric and topographic survey data collected by Rio ASE in April 2022. Data was used to create an AutoCAD Civil 3D surface in the North American Datum of 1983 (NAD 83), Washington State Plane South, U.S. Feet, coordinate system. The dataset vertical datum is the North American Vertical Datum of 1988 (NAVD 88). The spatial extent of this survey extends from 100 feet upstream of the North Fork and South Fork Coppei Creek bridges on the upstream end to the existing railway bridge at the downstream end of the project reach.
- 2018 LiDAR data collected for USGS by Quantum Spatial obtained online from the Washington State Department of Natural Resources Division of Geological and Earth Resources' Washington LiDAR Portal in raster format having a cell size of 3.28084 feet. The coordinate system of the dataset is North American Datum of 1983 HARN (NAD 83 HARN), Washington State Plane South, U.S. Feet, with linear unit in U.S. Feet. The vertical datum is NAVD 88.

4.4.2 Aerial Imagery

- 2021 National Agriculture Imagery Program (NAIP) imagery administered by the U.S. Department of Agriculture (USDA) Farm Service Agency obtained from ArcGIS Map Service. This imagery is shown in the hydraulic model result maps in Appendix C and was used in areas outside of where high-resolution drone imagery was obtained as described below.
- 2022 high-resolution drone imagery collected by Rio ASE in April 2022. The imagery was used to provide improved spatial reference to features and landmarks within the project reach and to determine land use, vegetation type, condition, and density for estimating Manning's n values used in the hydraulic model. Determination of Manning's n values are discussed in detail in a subsequent section.

4.5 Model Development

Development of any HEC-RAS 2D hydraulic model requires a terrain surface, delineation of the model domain, designation of hydraulic roughness (Manning's n values), creation of the model mesh, and designation of boundary conditions specifying the inflow(s) hydrology and conditions for outflow(s). Each of these major components of the hydraulic model are discussed in greater detail in subsequent sections.

The project reach where restoration actions are proposed begins approximately 100 feet downstream of the Coppei Road bridge crossing on North Fork Coppei Creek and extends downstream to the railroad bridge crossing Coppei Creek. No work is being proposed on South Fork Coppei Creek. The 2D hydraulic model domain extends approximately 400 feet upstream of the start of the project reach on North Fork Coppei Creek, includes approximately 800 feet of South Fork Coppei Creek upstream of the confluence with North Fork Coppei Creek, and extents approximately 300 feet downstream of the project reach covering approximately 8,200 feet of total channel length. Therefore, the model domain extends well upstream and downstream of the project reach to ensure accurate flow and inundation conditions at the start and end of the project reach.

4.5.1 Terrain

Rio ASE created a composite existing conditions terrain surface using AutoCAD Civil 3D by pasting the topographic and bathymetric datasets listed in Section 5.1.1 in the order of priority as listed. The resulting composite terrain surface was exported in *.tiff file format with a cell size of 1-foot and converted to a terrain within HEC-RAS. The composite existing condition terrain surface was used for hydraulic modeling as well as for design.

4.5.2 Hydraulic Roughness and Model Calibration

The existing conditions hydraulic model was calibrated to the water surface elevation (WSE) surveyed during the topographic and bathymetric survey in April 2022 with the corresponding measured flows shown in Table 4-1. Discharge measurements were performed at the same time as site survey. To begin the calibration process, high-resolution drone imagery was used to generate hydraulic roughness mapping for the full model domain. Using the aerial imagery as reference, polygons were digitized based on channel and vegetation type and other identifiable features listed in Table 4-2. A Manning's n value for the channel was first assigned based on engineering judgement and then adjusted until the residual difference between water surface elevations predicted by the model were best fit to observed water surface elevations. Calibration results are shown in Table 4-3. A Manning's n value of 0.08 was selected for final calibration and used in existing and proposed conditions model simulations at low flow (the 95% and 50% exceedance flows) as shown in Table 2-3. Annual Daily Exceedance Discharges (cfs) for the USGS Gage Locations and Coppei Creek Area 7 Project Reach Based on Average of a Logarithmic and Linear Regression Between Discharge and Basin Area. For model simulations at flows equal to and greater than the 5% exceedance flow, the channel Manning's n value was reduced by a factor of 0.5 to reflect the impacts of channel bed roughness during high-flow events more accurately. This reduction factor represents a dimensionless ratio of discharge/bankfull discharge correlated to Manning's n/bankfull discharge Manning's n values and was selected based on engineering judgement and founded on analyses completed by Rio ASE on numerous streams in the Intermountain West. Manning's in values for areas outside of the channel were selected based on engineering judgement and are constant regardless of the simulated flow, since overbank flow only occurs when flows are near or greater than bankfull. The selected Manning's n values in Table 4-2 are also consistent with published values in Chow (1959).

Table 4-1. Hydraulic Model Calibration Flows

Location	Discharge (CFS)
North Fork Coppei Creek	5.1
South Fork Coppei Creek	7.6
Coppei Creek	12.7

Table 4-2. Hydraulic Model Manning's n Values

Description of Feature	≥ 5% Exceedance Flow (78.6 cfs) Manning's n	Low Flow Manning's n
Main Channel	0.04	0.08
Main Channel Point Bars and Avulsions	0.09	0.09
Floodplain Pasture	0.10	0.10
Gravel	0.066	0.066
Floodplain Medium Brush	0.20	0.20
Floodplain Light Brush	0.14	0.14
Asphalt	0.032	0.032
Wood Structures and Riprap	0.20	0.20

Table 4-2. Hydraulic Model Manning's n Values

Description of Feature	≥ 5% Exceedance Flow (78.6 cfs) Manning's n	Low Flow Manning's n
Floodplain Forest	0.16	0.16
Existing Side Channels	0.06	0.08

Table 4-3. Hydraulic Model Calibration Results

Description	Discharge (cfs)
Minimum	-0.48
Average of Absolute Values	0.16
Maximum	0.44

4.5.3 Computational Mesh

The USACE's HEC-RAS 2D program uses a finite-volume solution scheme, which allows for use of a structured or unstructured computational mesh. This means that the computational mesh can be a mixture of 3- to 8-sided cells. The existing and proposed conditions hydraulic model uses a structured and unstructured mesh that contains variable mesh cell sizes ranging from 20-ft spacing to 5-ft spacing. Generally, the model mesh within floodplain areas that have a low topographic complexity use a nominal grid mesh (square cells) with a resolution of 20 feet by 20 feet. Channels or areas with high topographic complexity use a much finer mesh with variable-sided computational cells. For the mainstem Coppei Creek, the model mesh contains at least 3 mesh cells representing the channel bottom and 1 mesh cell representing the channel banks throughout the modeled reach. For side channels, the model mesh contains at least 1 mesh cell representing the channel bottom and 1 mesh cell representing the channel banks. To improve model accuracy and efficiency, breaklines were included to enforce cell size and to align the edges of mesh cells at locations of topographic change. These locations include top of existing and proposed banks, toe of slopes, centerline or thalweg of channels, top of roads, riffle crests, and any other areas requiring a more detailed mesh or where more complex hydraulic conditions are expected to occur.

4.5.4 Boundary Conditions

Boundary conditions designated within the model specify the flow rate(s) for flow entering the model (inflow) and conditions or flow rates leaving the model (outflow). The following are boundary conditions defined in the existing and proposed conditions hydraulic model:

- Upstream N. Fork inflow boundary
- Upstream S. Fork inflow boundary
- Downstream outflow boundary

The upstream inflow boundary flow rates are different for each model run. Peak flow rates used for each model run at the upstream boundaries are presented in Table 4-4. The downstream outflow boundary is set to normal depth and therefore uses the Manning's equation to compute normal depth at each computational mesh cell along the boundary, assuming an energy slope of 0.0105 ft/ft which is equal to the reach slope within 200 feet upstream of the model boundary.

Table 4-4. Upstream Boundary Conditions Inflow Discharges

Flow Statistic	Probability %	Upstream S. Fork Inflow (cfs)	Upstream N. Fork Inflow (cfs)
Maximum Peak Annual Discharge	0.2%	2022	1851
	0.5%	1567	1410
	1%	1273	1129
	2%	1020	886
	5%	733	621
	10%	549	454
	20%	389	312
	50%	205	156
	67%	147	111
	90%	78	59
	95%	60	46
	99%	38	29
Annual Daily Exceedance Discharge	95%	1.2	0.9
	50%	5	3.7
	5%	45	34

4.5.5 Structures

Bridge crossings are located on North Fork and South Fork Coppei Creek near the upstream model extents. These bridges are defined as culverts using 2D storage area connections in the hydraulic model. Details about each culvert crossing are provided in Table 4-5.

Table 4-5. Hydraulic Model Culvert Definitions

Culvert Feature	SF Coppei Creek Culvert	NF Coppei Creek Culvert
Type	Corrugated metal arch	Concrete rectangular box
Headwall	90% headwall	Side tapered with less favorable edges

Table 4-5. Hydraulic Model Culvert Definitions

Culvert Feature	SF Coppei Creek Culvert	NF Coppei Creek Culvert
Span (ft)	14.7	21.5
Rise (ft)	7.25	6.5
Length (ft)	28	44.5
Entrance loss coefficient	0.5	0.5
Exit loss coefficient	1.0	0.1

A dilapidated historic railroad trestle bridge crossing is located near the downstream extent of the project reach; however, this bridge is not defined as a structure in the hydraulic model. The model utilizes the terrain surface that includes surveyed topographic information defining the opening. All significant obstructions associated with the trestle bridge structure, including the bridge deck, are well above modeled water surface elevations and therefore were not incorporated into the hydraulic model.

4.5.6 Computational Method and Options

The existing and proposed conditions 2D hydraulic models were run using both the diffusion wave (DW) and shallow water equation (SWE) computational engines. The SWE set uses full Saint-Venant momentum equations. For all model runs, separate DW and SWE plans are created and are named with a “DW” for diffusion wave or “FM” for full momentum in the plan file. Each DW model run saves a restart file at the end of the model simulation, which is then used as the initial condition for the SWE model simulation. All model runs are performed using unsteady state boundary conditions and use a fixed time step; computational interval (time step) for DW model runs ranged from 1 to 2 seconds and time steps for SWE model runs ranged from 0.2 to 0.5 seconds. All other computation options and tolerances utilize HEC-RAS default settings.

4.6 Existing Conditions Model Results

Appendix C includes model results (depth, velocity, and shear stress) for the 95%, 50%, and 5% exceedance flows and various recurrence interval flows for both existing and proposed conditions. Interpretations of the existing conditions results are summarized as follows:

- Inundation extent (and WSE relative to existing bank heights) indicate the channel is disconnected from the floodplain throughout the project reach at the 1.5-year and 2-year flow events.
- The existing relic side channel on the right bank in the mid to lower portion of the project reach becomes activated at a flow between the 2-year and 5-year flow events.
- The middle portion of the project reach begins to experience some overbank flooding at the 5-year event however overbank flooding is absent in the upper and lower portions of the project reach at the 5-year and 10-year flow events.
- Depth, velocity, and shear stress results indicate a substantial lack of hydraulic variability throughout the project reach.

The project reach is confined, resulting in a lack of floodplain connectivity. Combined with a lack of large woody debris and relatively homogenous channel, the project reach provides little quantity and quality habitat value to juvenile salmonids.

4.7 Proposed Conditions Model Results

Appendix C includes model results (depth, velocity, and shear stress) for the 95%, 50%, and 5% exceedance flows, and various recurrence interval flows for both existing and proposed conditions. For proposed conditions, velocities in the mainstem channel are significantly lower compared to existing conditions as seen in the velocity results at the 2-year flow (Figure 13 of Appendix C). Reduced in-channel velocities are a result of increased floodplain connectivity, increased hydraulic roughness provided by proposed wood structures and backwatering caused by constructed riffles.

Floodplain connectivity throughout the project reach is significantly improved under proposed conditions. As seen in Figure 4 of Appendix C, the relic side channel in the mid- to lower portion of the project reach is fully activated at the 1.5-year flow, where under existing conditions this feature is activated at a flow between the 2-year and 5-year flow. Also, proposed inlet channels are activated at the 1.5-year flow. Flooding is occurring in the existing agricultural field in the upper and middle portions of the project reach at the 10-year flow. Future discussion and possible design refinements will be completed in a future design iteration to determine if the increased flooding poses a risk to private property.

Levee Removal – 1 near the confluence of the North Fork and South Fork Coppei Creek does not become activated until the 10-year flow. Future discussion and possible design refinements will be completed in a future design iteration to determine if the habitat value gained by this proposed feature outweighs the impacts of construction (impacts to existing vegetation). Levee Removal – 2 (located near the Blair property) is at the onset of activation at the 1.5-year flow. Flooding is observed at the 5-year and 10-year flows in the vicinity of existing infrastructure at this location and therefore future discussions about design refinements and considerations are also warranted.

Hydraulic variability (depth, velocity, and shear stress) throughout the project reach are improved under proposed conditions. Figure 4-1 and Figure 4-2 show depth and velocity histograms, respectively, at the 1.5-year flow. As shown in Figure 4-1, the standard of deviation and cell count (number of wetted cells) is higher under proposed conditions indicating a wider range of depths and greater inundation area by approximately 2.8 acres. Regarding velocity (Figure 4-2), the mean and standard deviation is lower for proposed conditions indicating more areas having slower velocities overall. The proposed model conditions show an increase in hydraulic diversity (greater depth range with more preferential flow velocities) compared to the existing conditions.

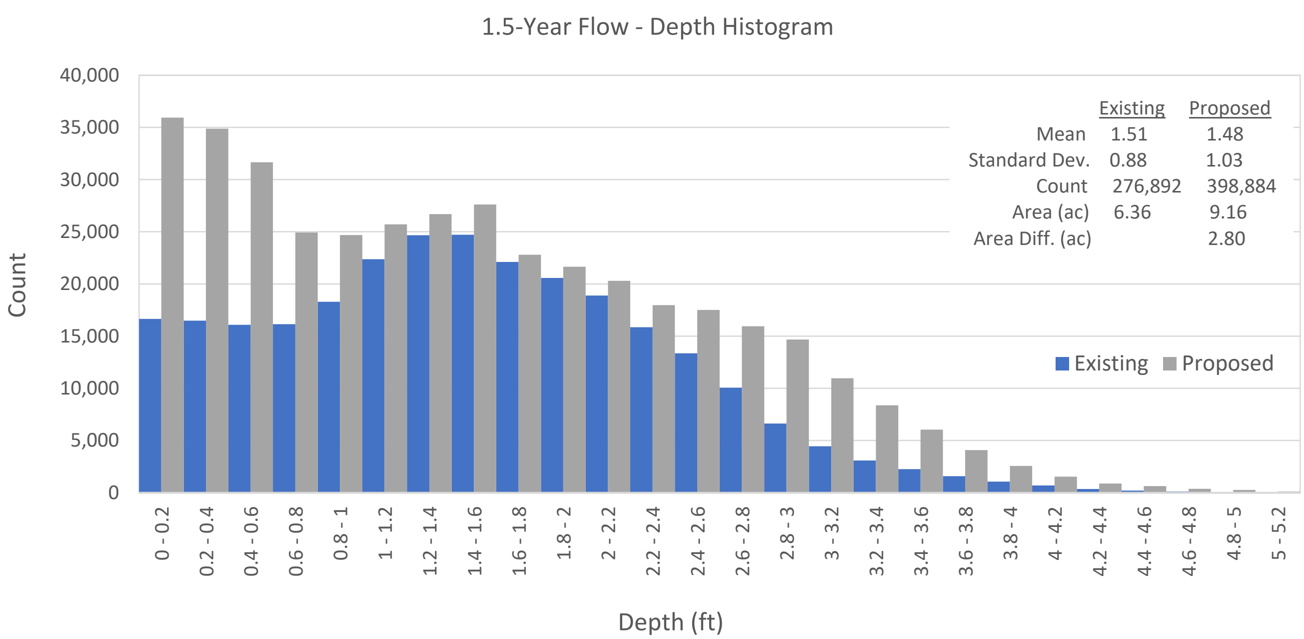

Figure 4-1. Depth histogram at the 1.5-year flow.

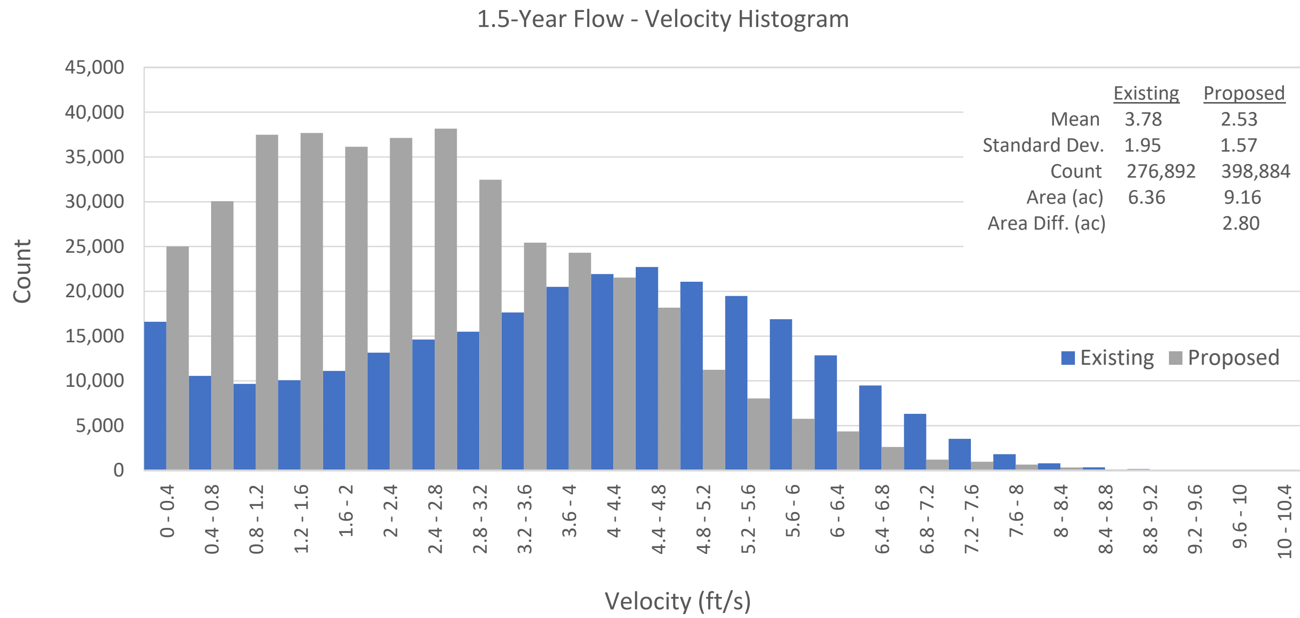

Figure 4-2. Velocity histogram at the 1.5-year flow.

5 PERMITTER AND STAKEHOLDER CONSULTATION

No regulatory or public consultation activities have occurred at this point in the design process. All comments addressed have been internal to Rio, the WWCCD, and the RCO. Regulatory and public consultation will occur at later stages of the design and will be documented here.

6 COST ESTIMATE

Construction based on the preliminary design has been estimated based on 2022 working conditions for southeastern Washington. The preliminary design estimate has been broken down into bid items, quantities, unit prices, and a total implementation estimate. At the preliminary design there is still a wide direction the project can head and therefore a considerable contingency is added to this estimate to account for future alterations. In addition to the implementation costs, Rio has included costs to assist in contractor selection and support throughout construction. These efforts include a pre-bid meeting, pre-con meeting, and several site visits during construction to ensure the contractor is meeting the design intent and following construction specifications. The additional costs for engineering services during construction are presented in Appendix D while the implementation cost estimate can be found in Appendix E.

7 NEXT STEPS

7.1 Design

Current designs shown in Appendix B are at a preliminary design level assumed to be at approximately 30%. This project, assuming it moves forward, will develop a 60% design, a 90% design, and a final design. These three design iterations are associated with standard review periods for funding entities and permitting services. Designs as early as 60% can be used for implementation, funding requests, and permitting. The 90% design can often be used for the construction bidding process while the final designs are approved for construction. Rio ASE has provided an estimate to carry the design process from the current 30% preliminary design through final design. This effort assumes an additional site visit, an aquatic resources inventory (wetlands delineation), two more review periods (60% and 90%), and continuing coordination with the WWCCD and other entities. This additional design services cost estimate can be found in Appendix D.

7.2 Timeline

It is anticipated that design efforts will continue through 2023 and into early 2024 with implementation occurring at the earliest in 2024, but potentially 2025 depending on funding availability.

8 LIMITATIONS

Some clients, design professionals, and contractors may not recognize that stream and river engineering analysis and design practices are less exact than other engineering and natural science disciplines. Such misunderstandings can create unrealistic expectations, sometimes leading to disappointments, claims, and disputes. Rio ASE includes these explanatory "limitations" provisions in our reports to help reduce such risks. Please confer with Rio ASE if you are unclear how these "Report Limitations and Guidelines" apply to your project or site.

8.1 Design Purposes, Persons, and Projects

This report has been prepared for the Client and their authorized agents and regulatory agencies for use on the Project(s) specifically designed in the report. The information contained herein is not applicable to other sites or projects.

Rio ASE structures its services to meet the specific needs of its clients. No party other than the Client may rely on the product of our services unless we agree to such reliance in advance and in writing. Within the limitations of the agreed scope of services for the Project and its schedule and budget, our services have been executed in accordance with our Agreement and generally accepted practices in this area at the time this report was prepared. We do not authorize, and will not be responsible for, the use of this report for any purposes or projects other than those identified in the report.

8.2 Design Factors

This report has been prepared solely for this Project and Client. Rio ASE considered a number of unique, project-specific factors when establishing the scope of services for this project and report. Unless Rio ASE specifically indicates otherwise, it is important not to rely on this report if it was:

- Not prepared for you,
- Not prepared for your project,
- Not prepared for the specific site, or
- Completed before project changes were made.

For example, changes that can affect the applicability of this report include those that affect:

- The function of the proposed design and/or structure,
- Elevation, configuration, location, or orientation of the proposed structures,
- Composition of the design team, or
- Project ownership.

If changes occur after the date of this report, Rio ASE cannot be responsible for any consequences of such changes in relation to this report unless we have been given the opportunity to review our interpretations and recommendations in the context of such changes. Based on that review, we can provide written modifications or confirmation, as appropriate.

8.3 Conditions Can Change

This report is based on conditions that existed at the time the study/design was performed. The findings and conclusions of this report may be affected by the passage of time, by man-made events such as construction on or adjacent to the site, new information or technology that becomes available subsequent to the report date, or by natural events such as floods, earthquakes, slope instability, stream flow fluctuations, or stream channel fluctuations. If more than a few months have passed since issuance of our report or work product, or if any of the described events may have occurred, please contact Rio ASE before applying this report for its intended purpose so that we may evaluate whether changed conditions affect the continued reliability or applicability of our conclusions and recommendations.

Any designs associated with this report may need to be adjusted in the field during construction in order to meet the site-specific conditions and intended function. Rio ASE cannot assume responsibility for the recommendations in this report if unexpected conditions are encountered during construction. We recommend that you allow sufficient monitoring and consultation by Rio ASE during construction to confirm that the conditions encountered are consistent with those indicated in the report, to provide recommendations for design changes if the conditions revealed during the work differ from those anticipated, and to evaluate whether construction activities are completed in accordance with our recommendations.

8.4 Report Misinterpretation

Misinterpretation of this report can result in costly problems. Rio ASE can help reduce the risks of misinterpretation by conferring with appropriate stakeholders after submitting the report, participating in pre-bid and preconstruction conferences, and providing construction observation.

To help reduce the risk of problems, we recommend giving contractors the complete report, including these "Report Limitations and Guidelines." When providing the report, we recommend that you preface it with a clearly written letter of transmittal that:

- Advises contractors that the report was not prepared for purposes of bid development and that its accuracy is limited, and
- Encourages contractors to confer with Rio ASE and/or to conduct additional study to obtain the specific types of information they need or prefer.

8.5 Hazards of Instream Habitat Structures

Instream habitat structures (Structures) create potential hazards, including, but not limited to:

- Persons falling from the Structures and associated injury or death,
- Collisions of recreational users and their watercraft with the Structures, and associated risk of injury, and damage of the watercraft,
- Mobilization of a portion or all of the Structures during high water flow conditions and related damage to downstream persons and property,
- Flooding,
- Erosion, and
- Channel avulsion.

In some cases, Structures are only intended to be temporary, providing temporary stabilization while riparian vegetation becomes established or while stream/river processes stabilize. This gradual deterioration with age and vulnerability to major flood events make the risks with temporary Structures inherently greater with their increasing age.

Rio ASE strongly recommends that the Client appropriately address safety concerns, including but not limited to warning construction workers of hazards associated with working in or near deep and fast-moving water and on steep, slippery, and unstable slopes. In addition, signs should be placed along the enhanced stream reaches in prominent locations to warn third parties, such as nearby residents and recreational users, of the potential hazards noted above.

8.6 Channel Response is Unpredictable

In general, rivers and streams are dynamic and unpredictable. Any predictions regarding future channel evolution and/or response either stated or implied in this report or associated design(s) shall be considered an estimate based on professional judgment given the data available and conditions that existed at the time the study/design was performed. Channel evolution and/or response may include but is not limited to erosion, deposition, channel migration, avulsion, flooding, and sediment and debris transport. Channel evolution and/or response is inevitable, and it should not be assumed that any condition, whether natural or constructed, will persist unchanged indefinitely in a riverine environment.

8.7 Monitoring and Maintenance

In some designs, Rio ASE may have excluded piles, anchors, chains, cables, reinforcing bars, bolts, and similar fasteners from woody habitat structures with the intent of mimicking naturally occurring instream wood structures. In other designs, Rio ASE may have included such fasteners in woody habitat structures, if considered appropriate. While Rio ASE designs structures to be relatively stable during flood events, some movement of these structures is expected. We recommend that the Client implement appropriate monitoring and maintenance procedures to minimize potential adverse impacts at or near areas of concern and consider replacing, adjusting, and/or removing damaged, malfunctioning, or deteriorated components of structures.

8.8 Construction Site Safety

Our recommendations are not intended to direct the construction contractor’s procedures, means, methods, schedule, or management of the work site during construction of any project associated with this report. The construction contractor is solely responsible for job site safety and for managing construction operations to minimize risks to on-site personnel and adjacent properties.

9 REFERENCES

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APPENDIX A: DESIGN ALTERNATIVES

APPENDIX B: CONCEPTUAL (30%) DESIGN DRAWINGS

APPENDIX C: HYDRAULIC FIGURES

APPENDIX D: ENGINEERING DESIGN SERVICES ESTIMATE

APPENDIX E: ENGINEER’S CONSTRUCTION IMPLEMENTATION ESTIMATE

APPENDIX F: COMMENT RESPONSE FORM